SATURDAY, SEPTEMBER 9, 1933

No. 3332 Vol. 132

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Biochemistry and Biology

A QUIET revolution is taking place in biological thought. The age of faith is past. No longer is either mechanism or vitalism upheld with religious fervour; no longer do we cling to the Victorian creed that all things are ordered mechanically, or to its counterpart, that organic events are ruled by some immaterial agency. As Sir Frederick Gowland Hopkins said in his presidential address at the Leicester meeting of the British Association, "It is characteristic of the present position and spirit of science that sounds of the long conflict between mechanists and vitalists are just now seldom heard".

This does not mean that either vitalism or mechanism has triumphed; it means that the field of discussion has shifted. It is now generally recognised that science cannot give us ultimate truth. We can fit various hypotheses to Nature, and the mechanistic one has served, and continues to serve, a very useful practical purpose, in stimulating and guiding research. Vitalism, at least in its dualistic form, has been essentially a critical rather than a constructive doctrine, and its main service has been as a much needed corrective to mechanism. But we realise now that neither view has any claim to absolute truth. The controversy between mechanism and vitalism has come down from the misty heaven of faith to the solid earth of practice, and what we are nowadays interested in is not the question, "Is the mechanistic theory true?", but the more practical one, "Is it adequate as a general biological method?" In addition, we have now as an alternative to mechanism, not dualistic vitalism, but a modern doctrine which may be described as the holistic or organismal.

These questions of biological method have been discussed during the past week from two points of view at the British Association meeting, incidentally by Sir Frederick Gowland Hopkins in connexion with his brilliant exposition of the advance of biochemistry, and directly by Dr. James Gray in his address to Section D on "The Mechanical View of Life".

Sir Frederick Gowland Hopkins defines the aim of biochemistry to be the furnishing of "an adequate and acceptable description of molecular dynamics in living cells and tissues", and he shows that great strides have been made towards achieving this ideal. Thus the power which the living cell

possesses of selecting from its environment just those substances which it requires for maintenance and growth appears to be susceptible of a purely chemical explanation. "It is, however, no vital act but the nature of its specific catalysts which determines what it effectively 'selects'." The action of hormones and vitamins, which are relatively simple substances with definite chemical properties, also appears in principle to be explicable in biochemical terms.

"It is an immediate task of biochemistry to explore the mechanisms of such activities. It must learn to describe in objective chemical terms precisely how and where such molecules as those of hormones and vitamins intrude into the chemical events of metabolism. It is indeed now beginning this task, which is by no means outside the scope of its methods".

It is not claimed, however, that all the activities of living systems are based upon chemical organisation alone. This organisation, in Sir Frederick's considered opinion, accounts for one striking characteristic of every living cell—its power to maintain dynamic individuality in a varying environment. But cells and organisms exhibit other powers—of growth, differentiation, reproduction—and "it is not illogical to believe that such attributes as these are based upon organisation at a level which is in some sense higher than the chemical level".

While, then, biochemistry has fully justified itself in its study of the molecular dynamics of cells and tissues, at the higher levels of organisation, other methods, other concepts, may be necessary. The way is here left open to some form of holism.

The objection has often been raised to the analytical or physiological method that it studies only the parts of the organism in isolation from the whole, and neglects, what is fundamentally important, the relations of the parts to the whole, their co-ordination or weaving together into one functional unity. Sir Frederick Gowland Hopkins does not accept this limitation as inherent in the method, and maintains, against Prof. J. S. Haldane, that a knowledge of the whole can be best acquired by a study of the parts. Physiology, he holds, is "entitled to claim that its studies of parts are consistently developing its grasp of the wholes it desires to describe, however remote that grasp may be from finality". Analysis by itself is admittedly not enough, but it can be followed by intellectual synthesis, which will give us a fuller and more adequate conception of the activities of the organism as a whole.

Dr. Gray, in his address, maintained, and with full justification, that "the conception of the organism as a single living entity is, or should be, the more peculiar attribute of experimental zoology". While the biochemist and the physiologist study parts, the biologist studies (or should study) wholes. Thus the physiologist may properly investigate the properties of the sartorius muscle of the frog, in isolation from the rest of the frog's activities; what the zoologist is interested in is how the frog jumps, and how its sartorius acts in relation to its method of locomotion. (One might of course go a step further, and suggest that what is really of interest to the zoologist is not so much the method of locomotion as the behaviour of the frog—in what circumstances, and why, the frog jumps.) But the experimental zoologist finds it easier to start with what looks like the simpler problem, the functions of the isolated parts, and in practice he tends to make common cause with the physiologist and discuss vital activities in terms of cell-functions, and ultimately in terms of the physico-chemical properties of living matter. This leads, as Dr. Gray pointed out, to an over-simplification of the problem.

We have no right to assume beforehand that we can express all the properties of the organism in terms of physical and chemical laws, and if we look at the facts squarely we find little apparent justification for such a belief. For example, the spontaneous origin of living systems from inanimate matter, which is a matter of faith with the mechanist, is an event so highly improbable from the physical point of view that no physicist or chemist would be justified in considering its possibility seriously. For the differentiation of structure and function which takes place in development no physical explanation seems to be possible, and we are forced to postulate the possession by living matter of intrinsic properties or potentialities which are as fundamental and mysterious as the intrinsic properties of a radioactive molecule.

We may, if we like, think of a developing egg cell as a highly complex dynamical system which is physically unstable—"but where in the chemical world do we find such unstable systems acting in such a way as to build up and not to break down a highly complex structure?"

It seems, then, that we must accept, at least provisionally, in addition to the physical and

chemical properties which they undoubtedly possess, the existence in living systems of intrinsic properties or potentialities, which are without parallel in the inanimate realm. In Dr. Gray's view, we must accept these potentialities as given or axiomatic, certainly at present.

Comparing the views of Sir Frederick Gowland Hopkins and Dr. Gray, we see that while the former holds that there may be levels of organisation where physical and chemical concepts are inadequate, the latter is convinced that this is definitely so, at least in the present state of our knowledge. Both agree that an understanding of the organism as a whole is the essential aim of biology; both reject dogmatic materialism.

This brings us back to our starting point. There is nowadays no room for dogmatism about the nature and origin of life. The real problem is simply one of method. Is it sufficient to treat the living organism as a complex physico-chemical system, and direct all our energies towards a closer analysis of it—to a study of its parts, regarded as chemical mechanisms—or must we recognise that it has properties and potentialities as a whole, and at certain levels of organisation, which are not reducible to the properties shown at the chemical level? The second alternative is that proposed in the organismal theory, and it seems to receive strong support from the arguments put forward by Dr. Gray, while it is not in conflict with the position taken up by Sir Frederick Gowland Hopkins.

This view accepts as fundamental the obvious fact that the living thing is a unity. It maintains that the organism as a whole manifests activities which are not mere summations of the activities of the parts, and accordingly that the whole cannot be satisfactorily reconstituted from the parts. The biologist, if he accepts the organismal view, cannot rest content with physico-chemical studies of the parts of the organism, which are the proper concern of the physiologist and the biochemist, but must study also and before all, the activities of the organism as a whole, in behaviour, development, reproduction and so on. He is at full liberty to use the general method of analysis, in order to deepen his knowledge of the parts in relation to the whole, but he must work down from the whole to the parts, rather than upwards from the parts to the whole. This is, as we conceive it, the proper method for biology to pursue.

Makers of Science

Great Men of Science: a History of Scientific Progress. By Philipp Lenard. Translated from the second German edition by Dr. H. Stafford Hatfield. Pp. xix+389+48 plates. (London: G. Bell and Sons, Ltd., 1933.) 12*s.* 6*d.* net.

AMONG scientific men, the degree of interest in the history of their subject varies curiously with age. As a rule, the young investigator has little interest in the origins of the scientific conceptions with which he works; it is only later when he has gained some personal experience of the ways in which new knowledge is secured, and the way in which the new developments are linked with the past, that he begins to take an interest in the history of his science and the achievements and personalities of the great pioneers.

In order to form a just idea of the relative importance of the work of different scientific men, it is essential not only to estimate the intrinsic value of their individual achievements, but also to take into account the prevalent ideas and the state of laboratory technique in their science in the period under consideration. We should thus expect to get a more balanced estimate of the achievements of scientific pioneers from one who is familiar at first hand with the scientific method, and has himself contributed to new knowledge, rather than from the professional historian however competent he may be in his own domain.

For these reasons, I have read with much interest and curiosity the book entitled "Great Men of Science" written by Prof. Philipp Lenard, for many years professor of physics in the University of Heidelberg, so well known to all physicists as a scientific investigator of great originality and power. The great men he has selected are in his own words those "who have brought forward something entirely new, having an essential bearing on our knowledge of nature, on our view of the universe and the position of man in nature". He begins with a brief account of the work of Pythagoras, Euclid and Archimedes and ends with Boltzmann, Hertz and Hasenöhrl. No man alive at the end of the War is included, except Crookes and Van der Waals, whose work was essentially complete before that period.

This is a book of very unusual character; in nearly every case the man himself as well as his scientific discoveries is brought vividly before the reader's mind. Lenard is interested not only in

showing what new knowledge the men contributed but also in showing that their personal greatness matched their scientific achievements. The lives in most cases are brief, but always the nature of the advance in knowledge is brought out while the analysis is often most illuminating. Lenard considers the man and his work in relation to the state of knowledge at that time, and shows exactly the nature of his contribution.

The amount of space given to the lives varies from half a page or so for the older investigators about whom little is known to 17 on Faraday and 28 on Newton, with an average length of 5 or 6 pages. In a number of cases, a group of men are dealt with together, for example, Scheele, Priestley and Cavendish; Galvani and Volta, Davy and Berzelius; Mayer, Joule and Helmholtz; Hittorf and Crookes. This method has definite advantages both for comparison and brevity. All his great men are known for their contributions to physics and chemistry, except Darwin, Linnæus and Mendel. It may be that in some cases Lenard's judgment is contrary to accepted opinion, but if this is so it is the result not of personal prejudice but of a very close study of the subject. In fact, the whole book is singularly free from all trace of that scientific nationalism which is occasionally manifest in scientific writings to-day. In his preface Lenard tells us that in order to form a just opinion he read carefully not only historical works on science but also the actual publications of the men themselves. He makes the penetrating remark:

"This study of the works of great investigators taught me that they had frequently achieved much more than they were usually given credit for. The richer the contents of their work, the more of it appeared to have been forgotten in course of time by the writers of histories and text books; or rather, the credit tended to be given to others who had later turned their attention to the subject and enlarged upon it when it was no longer new."

Throughout this book, there is manifest the joy of Lenard in scientific discovery, his love of scientific truth and his admiration for an upright man. No one can read his appreciation of the work of Newton and Faraday, for example, without feeling his admiration and almost veneration for their achievements and character.

Lenard's ideal of the man of science is the practice of straightforward scientific thinking in direct contact with Nature. He has little sympathy with the glorification of purely technical achievement, whether by experiment or calculation, but he delights in any ideas which give a simpler or a new insight into natural phenomena. He does not hesitate to express his disapproval of certain aspects of scientific activities of to-day, for example, the teaching of science in the schools and universities, and deprecates a materialistic outlook in science. He considers that the importance of mathematics in scientific discovery is generally overrated, although he fully recognises its value in working out the consequences of simple ideas in complicated cases. He emphasises that the quantitative relation involved in many of the greatest discoveries are of the simplest possible character not involving more than an elementary knowledge of mathematics. There are naturally many different shades of opinion on such a controversial subject, but I think it is generally recognised to-day that advance in science is most rapid and definite when the experimenter and the mathematical theorist work in close contact.

In the discussion of the life and work of his pioneers interesting remarks are often interposed, many of which, if space allowed, might well be quoted. In referring to the relations between the Royal Society and Newton, he makes the statement:

"We thus again see quite clearly that great advances only come from single personalities and not from Societies, no matter how excellent the persons may in general be of which they are composed. Such Societies should therefore see their province exclusively in protecting and forwarding the work of the single and all too rare individuals who show themselves to be bringers of progress in any direction."

Few will question the accuracy of this view, which expresses in general the working ideal of our Royal Society to-day.

Excellent portraits are included of the great majority of his pioneers, and these form a background for an account of their lives and personalities which are in general brief and to the point.

This translation from the second German edition has been well carried out by Dr. H. Stafford Hatfield. A well-considered preface has been added by Prof. E. N. da C. Andrade, himself an old pupil and admirer of Lenard and his work.

This book is undoubtedly a remarkable achievement and is in itself a valuable original contribution to science. The reader who is interested in science

will unwillingly skip a single page of this fascinating story of the work of great men, and many will wish to re-read parts again and again.

We warmly congratulate Prof. Lenard on his achievement in giving us such a masterly presentation of many of the great men of the past. His book should be read by everyone interested in science whether as a teacher or investigator, and I am sure it will lead to an even greater appreciation of the singleness of purpose and of the high ideals of those great men who laid the foundation of our sciences. RUTHERFORD.

Submarine Biology

Nonsuch: Land of Water. By Dr. William Beebe. Published under the auspices of the New York Zoological Society. Pp. xv+245+47 plates. (London and New York: G. P. Putnam's Sons, Ltd., 1932.) 21*s.* net.

TIME was when men dreamed of competing with the birds in mid-air, but in more sober moments the realisation of this dream was regarded as a forlorn hope. To-day it is an accomplished fact; and now fresh fields to conquer are being explored 'fathoms deep' beneath the sea.

This conquest was begun by the diver, for purely utilitarian ends, but Dr. William Beebe, director of the Department of Tropical Research of the New York Zoological Society, some years ago began devising methods whereby the living animals of the sea might be studied at close quarters, as we study birds and beasts. The astonishing success which has attended his efforts are well known, and marine zoologists are under no misapprehension as to the debt they owe him. For it is well enough to glean from the harvest of the sea by means of nets, but even better to go down in place of the net, and study the ways of the creatures of the deep as they live, and move, and have their being. This Dr. Beebe has contrived to do: and as yet he stands almost alone in this new mode of research, carried on, sometimes, at a depth of eight fathoms.

Some of Dr. Beebe's achievements are recorded in the volume now before us, wherein he gives us a vivid and most valuable account of his work around Nonsuch Island, one of the Bermudas, and from which his book derives its title. One instance of the strange things this volume contains must suffice. Dr. Beebe had been lowered to a depth of eight fathoms, and landed on a mass of coral. Pieces kicked off this soon brought crowds of hungry fishes to the spot. "If I derived any satisfaction from being a freak pioneer, I could boast that I was the first human being who had fed fishes by dancing on coral-tops eight fathoms down. The fish were considerably larger than those of the inshore reefs: blue surgeons and angel-fish, giant butterflies, parrots over four feet. . . . Now and then I see a fish new to our list, or even to Bermuda."

One is left wishing that Dr. Beebe had given us rather more of his work in this underworld; but not at the expense of his most interesting survey of the animal life of the rock-pools and shore, and of the birds of the island, for these all have a bearing, more or less direct, on the life of the deeper waters.

The Mistress to the Theoric

Anschauliche Geometrie. Von D. Hilbert und S. Cohn-Vossen. (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen, herausgegeben von R. Courant, Band 37.) Pp. viii+310. (Berlin: Julius Springer, 1932.) 25.80 gold marks.

A FOUR-HOUR lecture by Prof. Hilbert has been expanded by Dr. Cohn-Vossen, in a pleasant style perfectly suited to the subject, into surely the most fascinating volume ever offered to the ordinary mathematician. Consider the main topics: thread constructions and linkages; lattices, with applications in two dimensions to the theory of numbers and in three dimensions to crystallography; the simpler configurations, including the double-six; the elements of differential geometry, with an account of the elliptic and hyperbolic planes; and lastly, topology, with a long section on one-sided surfaces, and a proof of the fundamental fixed-point theorem in the theory of continuous transformations, as well as an exact statement of the difficulties in the familiar four-colour problem.

The scope may be indicated by reference to a long section entitled "Eleven Properties of the Sphere", where under the heading "The sphere has no focal surface" we find an account of Dupin's cyclides, introduced as the surfaces for which the focal surfaces degenerate to curves; under the heading "All the geodesics on a sphere are closed curves" we learn why a motor-car must have a differential; and under the heading "The sphere has constant positive Gaussian curvature"

we are told that a closed convex surface is absolutely rigid if it is indeformable.

Over-educated, we are prone to look with suspicion on expositions of this kind. Of all names in the world, perhaps Prof. Hilbert's gives the best guarantee that the eye is not to be allowed to deceive the mind. Moreover, we are reminded again and again that analysis must supply a proof in cases where intuition makes a result only plausible, and sometimes we are warned that the investigation is difficult, but it is the range rather than the limitations of intuitional methods that will be a revelation to many readers.

The book is amply illustrated, partly by photographs, and partly by most careful and vivid diagrams, for the sake of which it should be in the draughtsman's office of every firm which has textbooks or treatises on geometry to produce.

The firm of Springer, which has for many years been very active on the board of mathematical publications, is to be congratulated on the success of a move which is appropriately not along one of the direct lines. If I deplore the price of the volume, it is not with any suggestion that it is excessive but only out of regret that it puts the work beyond the reach of hundreds of mathematical students and teachers to whom it would be an inspiration and a delight. E. H. N.

Jurassic Rocks of Britain

The Jurassic System in Great Britain. By Dr. W. J. Arkell. Pp. xii + 681 + 42 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1933.) 30*s*. net.

NEARLY forty years have elapsed since the publication of the Geological Survey monographs on the Jurassic rocks of Britain. In the interval, much research on these formations has been carried out by a small band of enthusiastic workers, prominent amongst whom was the late S. S. Buckman; and the absence of a volume co-ordinating the results of their studies has been viewed almost with reproach, since the sections in England are virtually the standards of comparison for the world. Few workers, however, have had time or experience to tackle what had become a formidable task. Fortunately, for the honour of British geology, Dr. Arkell has stepped forward. With youth in his favour, leisure enough to concentrate the whole of his energies to the work and thereby rapidly gain a wide experience of the formations in the field; an outstanding capacity to digest the literature, combined with the possession of a logical mind and a rare facility in the art of expressing the salient facts in crisp, lucid English, he has written a book which places every student of the Jurassic rocks, British and foreign alike, under a deep debt of gratitude to him. The volume will rank for many a year to come as the most authoritative account of these formations in Britain, and the success which has attended his efforts raises the hope that other authors will follow his lead and produce similar volumes on the other geological systems in Great Britain.

The book is divided into four parts. In the first is given a clear exposition of the principles underlying the various schemes of classification which have come into use since the days of William Smith. In this the author has much to say in regard to the work of S. S. Buckman. Generally, Dr. Arkell is judiciously impartial, praising the early constructive work of this great British palæontologist, but roundly chastising him for the errors he perpetrated in his later studies, particularly those to be found in the last few parts of "Type Ammonites". Emphasis is thus laid on the fact that palæontological studies divorced from field-work are likely to prove worthless and misleading.

In the two succeeding parts the general structure of the basins of deposition, the contemporaneous tectonics and their effects on sedimentation, and the formations themselves, are ably discussed. The author has added much to the value of the stratigraphical chapters by submitting them before publication to various competent geologists for criticism, and as a result each chapter may be said to carry the seal of authority. In the concluding part the information given respecting the distribution of corals and ammonites contains much that is new, and in the section dealing with the general boundaries of the Jurassic troughs, Dr. Arkell discusses the various views put forward in a characteristically illuminating manner.

The book is enriched by many illustrations, and a number of plates at the end are devoted to fossils of zonal value. Merely to mention that many of the photographs are the work of Mr. J. W. Tutcher is sufficient to testify to their high degree of excellence. There is a useful appendix giving a list of 120 stage names hitherto proposed, and an extensive bibliography. J. P.

Short Reviews

Applied X-Rays. By Prof. George L. Clark. (International Series in Physics.) Second edition. Pp. xiv+470. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1932.) 30*s.* net.

"THIS science, it keeps going on," remarked one of the more plebeian of Mr. Wells's galaxy of characters. The thought is platitudinous, but it is inevitable when one compares the drawing of the primitive cathode ray tube used by Röntgen with that of, say, the Hadding-Siegbahn tube used in crystal analysis, or the Siemens-Pantix deep-therapy tube operating at 400 kv. and 5 ma. We read now of high voltage tubes that have been constructed to operate at 2,600,000 volts, in which electrons are so speeded that they drill holes an inch deep in a brass plate. An almost incredible advance since that winter's day, but a little more than a generation ago, when Schuster, calling at his laboratory for his letters, forgot his family and his dinner in the fascination of reading a paper, just received by post, on "Eine neue Art von Strahlen".

Dr. Clark chronicles these advances clearly and succinctly. His book, as its title implies, is concerned primarily with the practical side and, of the two parts into which it is divided, the first and shorter part is concerned with the details of tubes and equipment, spectra, chemical analysis, absorption and scattering, radiography and chemical, physical and biological effects. In the second part, nearly 300 pages are devoted to the X-ray analysis of the ultimate structures of materials.

In the second edition the book has been almost entirely recast and forms an admirable manual of the subject of X-rays on the applied side. A. F.

A Psychologist's Point of View: Twelve Semi-popular Addresses on various Subjects. By Charles S. Myers. Pp. vii+207. (London: William Heinemann (Medical Books), Ltd., 1933.) 7*s.* 6*d.* net.

THIS is a collection of semi-popular papers on a dozen diverse subjects, all treated from the point of view of a psychologist. The name of Dr. C. S. Myers, principal of the National Institute of Industrial Psychology, is of itself a guarantee that the truly scientific attitude is maintained throughout. A good example is the paper on Freudian psychology, which combines candid and searching criticism with just appreciation of a distinguished man's contribution to the subject. Three of the papers deal with important points in industrial psychology. A particularly helpful paper is the one in which the true relation between instinct and intelligence is unfolded. There are few psychologists, if any, who have done so much as Dr. Myers for the application of psychological principles to practical problems of life; and this book well exemplifies the spirit and method of his work.

Atomic Energy States: as Derived from the Analyses of Optical Spectra. Compiled by Dr. Robert F. Bacher and Prof. Samuel Goudsmit. (International Series in Physics.) Pp. xiii+562. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1932.) 36*s.* net.

AN important and interesting compilation, intended to give numerical values of energy levels of atoms and ions investigated up to "the present". The authors believe that the record is complete up to the spring of 1931, and include, moreover, much unpublished material concerning work later than this date. The volume is almost entirely in tabular form, an introduction of 21 pages being followed by about 520 pages of tables in which the classifications and term values are arranged in alphabetical order of the emitters from A I to Zr IV.

The book is critical, and will form a most valuable addition to the working library of the spectroscopist.

Optik: ein Lehrbuch der elektromagnetischen Lichttheorie. Von Prof. Dr. Max Born. Pp. vii+591. (Berlin: Julius Springer, 1933.) 38 gold marks.

THE sub-title of this scholarly volume indicates the direction of approach to the subject taken by the author. It must be noted, also, that the work contains a concise but valuable section of some sixty pages dealing with the fundamental problems of geometrical optics. The author then proceeds to develop his subject by successive chapters on interference, diffraction, crystal- and metal-optics, and molecular optics, concluding with a very full treatment of emission, absorption and dispersion.

No more need be said of the book than that it is worthy of the reputation of Prof. Born. There are a number of errors which demand correction, and the publishers have recently put out a "Berichtigungszettel", which will, presumably, be supplied with all copies of the work now placed on the market. A. F.

Treatise on Sedimentation. Prepared under the Auspices of the Committee on Sedimentation, Division of Geology and Geography, National Research Council of the National Academy of Sciences. By William H. Twenhofel and collaborators. Second edition, completely revised. Pp. xxix+926. (London: Baillière, Tindall and Cox, 1932.) 46*s.*

THE second edition of this treatise has been revised and very considerably enlarged, and the number of illustrations increased. The revision incorporates information resulting from an extensive search of extra-American literature. In this respect an attempt has been made to remedy the deficiencies of the previous edition (see NATURE, 120, 327, Sept. 3, 1927). As it stands, the work constitutes a mine of information on sedimentary rocks and the processes of sedimentation.

Extremely Low Temperatures

By PROF. W. J. DE HAAS, University of Leyden

IN 1926 Debye pointed out that temperature must decrease when a magnetised body is demagnetised adiabatically. Giauque made the same remark in 1927; and still earlier the same idea was expressed by Langevin for oxygen. Debye calculated the predicted effect for the case of gadolinium sulphate. His calculation was

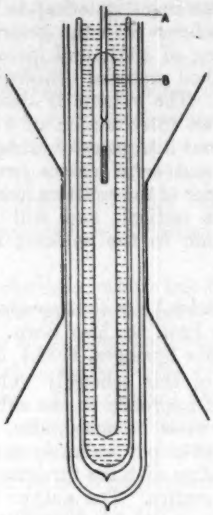

FIG. 1.

based upon the following considerations: a magnetisable body contains a great number of small elementary magnets. When such a body is magnetised these magnets are directed. The part of the entropy belonging to this order is decreased and, the process being supposed isentropic, the part of the entropy connected with the statistical movement must necessarily increase. When, on the contrary, the disorder of the elementary magnets is increased by demagnetisation, the part of the entropy connected with the magnetisation is increased and the part belonging to the statistical movement is decreased, so that the body is cooled down.

If we wish to obtain easily seen results, the following points require special attention: (1) the elementary magnets shall not exert a directing influence upon each other (no ferromagnetic body); (2) the elementary magnets shall have a moment as large as possible, subject to the restriction of (1); (3) at low temperatures the effect will be greatest, as here the part of the entropy belonging to the magnetisation becomes comparable with the other part, while at the same time the order strongly increases.

The condition to be fulfilled by the experimental arrangement in order to obtain extremely low temperatures is that the exchange of heat with the surroundings both by radiation and by connexion is cut down. In our experiments this condition is satisfied. The substance that is cooled down is at the same time used as a thermometer.

The experiments were made with cerous fluoride (a weakly paramagnetic salt of one of the rare earths) as suggested by Prof. Kramers, of Utrecht (see "Leipziger Vorträge", 1933). Fig. 1 very diagrammatically represents the experimental arrangement. The rod A is fixed to a balance. It carries a small Dewar flask, which contains a small tube filled with cerous fluoride and suspended by a central carrier B. The whole apparatus is placed between the poles of the large electro-magnet of the Kamerlingh Onnes Laboratory in such a way that the salt occupies the spot of maximum $H.dH/dx$ (x = vertical co-ordinate). The lower extremity of the rod A together with the small Dewar flask is surrounded by liquid helium boiling at 1·26° K. The thermal insulation of the cerous fluoride is so good, that after 4–5 hours only a very small quantity of salt of exceedingly low heat capacity (the latter is inversely proportional to T^3) is cooled down to 1·26° K.

We know that finally this temperature has been reached, because the salt is the indicator of its own temperature. This paramagnetic body is drawn into the field (31 k. gauss) by a force $K = M.dH/dx$, where M is the total moment of the body. As $M = \varphi(H, T)$ and as H remains constant, we easily see, by measuring K, when T has become constant.

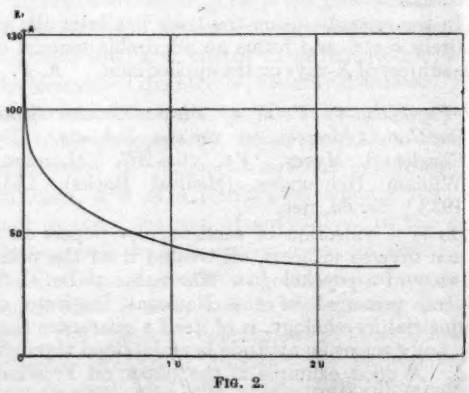

FIG. 2.

As soon as this is the case the body is demagnetised by lowering the field to 2·7 k. gauss in the first experiments, to 1,000 or 500 gauss in later experiments.

In this weak field the force K is measured as a function of the time. In this way we obtain a curve as shown in Fig. 2.

The point A on the curve corresponds to the force at the lowest temperature, while the asymptote after a long time corresponds to the

force at 1·26° *K*. The steep fall of the curve in the beginning is due to the fact that in the vacuum of the small Dewar flask a trace of helium (10^{-7} mm.) has been left intentionally for thermal contact. This helium gas is condensed under development of the heat of condensation. When the pressure of the helium gas is still lower, the curve has a different form and heating up with the time goes extremely slowly. The cold has been caught in a trap. The vacuum becomes practically absolute and heat is no longer transmitted.

The forces are directly proportional to the moments and the only thing we have to find out is to which temperatures these moments correspond. The connexion between temperature and moment has been determined between 7·2° *K*. and 1·3° *K*. The curve representing this connexion was extrapolated linearly, though this gives a stronger increase of the moment than the curve itself does. That is why we can only give an upper limit of the temperature reached.

The first experiments were made in March and April of this year with cerium fluoride and gave as the upper temperature limit 0·27° *K*. More recent experiments with dysprosium ethyl sulphate gave the upper limit 0·17° *K*. Finally, the experiments of July last made with cerium ethyl sulphate gave as the upper temperature limit 0·085° *K*.

It is possible that with the same experimental arrangement much lower temperatures can be reached. The choice of the right substance will decide further results. I am convinced that with the above-described arrangement the theoretical limit can be reached.

Up to the present, the lowest temperatures had been reached with the aid of liquid helium, boiling under very low pressures. The results of this method evidently depend upon the capacity of the pumps used and upon the perfection of the thermal insulation.

With this method Kamerlingh Onnes reached in October, 1921, a temperature of 0·82° *K*. Keesom worked with diffusion pumps of a capacity fifteen times higher than that of the pumps Kamerlingh Onnes had. In 1929 he reached a temperature of 0·71° *K*. It is, however, difficult to proceed much further in this way.

The conception of temperature is based upon the properties of the ideal gas. The temperature is determined with the aid of the helium thermometer (several corrections being applied). At the extremely low temperatures reached recently no gas thermometric measurement of the temperature is possible, so far as I can see.

A thermometric scale based upon another process must be fitted to the absolute temperature scale; only a magnetic scale can be used for this purpose.

Just as was done in gas thermometry, we shall have to find some substances, which within a considerable range of temperature show the same behaviour; a highly developed theory will then enable us to fix the temperature with the same accuracy by means of magnetic thermometry as by the use of gas thermometric methods.

A reservation must be made, however, for the case that at very low temperatures the substances used might become ferro-magnetic or might show a new kind of ferro-magnetism. In this case little might be said about the temperature.

Another great difficulty is this: if by means of the magnetic method we wish to cool down other substances, the question of the thermal contact becomes urgent. The radiation is negligible, and also the vapour pressure of the helium becomes so small that thermal contact by means of gaseous helium can scarcely be considered.

The experiments were made in collaboration with Dr. E. C. Wiersma, conservator of the Laboratory, to whom I express my warmest thanks for his help and for many suggestions. To Prof. H. A. Kramers of Utrecht I am indebted for his valuable theoretical assistance.

Intermediate Products and the Last Stages of Carbohydrate Breakdown in the Metabolism of Muscle and in Alcoholic Fermentation*

By Dr. Otto Meyerhof

FROM these new results we see that the assumption of the rôle of methylglyoxal as an intermediate product in the splitting of carbohydrates becomes superfluous. Upon the discovery of methylglyoxalase by Dakin and Neuberg, the whole biochemical world was seized with the idea that lactic acid formation must take place with methylglyoxal as an intermediate. This was also applied to the formation of pyruvic acid during alcoholic fermentation.

In the meantime, in our own laboratory the 'stock' of methylglyoxal had sunk to a low level. Lohmann's discovery of the part played by glutathione as the co-ferment of methylglyoxalase sent them down to rock bottom. In addition to the many important functions in the biochemistry of the cell which have been ascribed to Hopkins' glutathione, Lohmann has added a new one of great interest, namely, that glutathione acts as a true co-enzyme of methylglyoxalase. Now, after adding adenylpyrophosphoric acid and magnesium ion, glycogen was easily transformed into lactic acid in muscle extracts from which the glutathione had been dialysed away so that they could not convert methylglyoxal. It was also observed in new experiments that, with the same conditions, but in the presence of sulphite, pyruvic acid is formed, although, even in the presence of glutathione only traces of pyruvic acid are formed from

* Continued from p. 340.

methylglyoxal. We now recognise the formation of lactic acid as a true oxidation-reduction process in which the previous puzzling rôles of pyruvic acid as well as that of the esterification of the hexoses receive a new significance.

This observation is important also in deciding the question as to exactly where the two processes of alcoholic fermentation and lactic acid formation leave their common path. This question has occupied me for the past three months. Neuberg has assumed pyruvic acid as an intermediate in his well-known fermentation scheme, basing his hypothesis upon the discovery of carboxylase. Although this part of the scheme is now to be regarded as proven, one must also here remove the erroneous assumption that the pyruvic acid is derived from methylglyoxal. Neuberg himself had in the meantime shown for dry yeast, exactly as Embden had for muscle tissue, that phosphoglyceric acid can be transformed into pyruvic acid. It follows then, as can readily be shown, that in fresh yeast extract phosphoglyceric acid would be briskly decomposed into acetaldehyde and carbon dioxide. On the other hand, Nilsson had isolated, so early as 1930, phosphoglyceric acid from dry yeast in the presence of fluoride, hexose di-phosphate, and acetaldehyde.

In maceration juice containing fluoride, exactly in the same manner as in muscle extract, hexose di-phosphoric acid is actually converted into Lohmann's 'unhydrolysable ester', consisting of equimolecular portions of glycero-phosphoric acid and phosphoglyceric acid. The phosphoglyceric acid, added to fresh yeast extract, decomposes, as shown, into carbon dioxide, phosphoric acid and acetaldehyde. However, α-glycero-phosphoric acid does not react further and, since added sugar or hexose di-phosphoric acid is completely fermented by yeast, this stable compound cannot be formed during fermentation. The reduction of the aldehyde, therefore, is not accomplished by the glycero-phosphoric acid, but in another manner. Nilsson in Euler's institute had already come across this reaction, but he failed to recognise its importance. Apart from the presence of carboxylase, this peculiar reaction is the principal difference between alcoholic fermentation and lactic acid production.

Nilsson established that when fluoride, glucose, hexose di-phosphate, and acetaldehyde are added simultaneously to dry yeast, with no fermentation taking place whatsoever, aldehyde is reduced to alcohol and sugar is simultaneously esterified. He identified the resulting ester as probably being phospho-glyceric acid. His observation was correct. I have followed the reaction further quantitatively and found two noteworthy fermentation equations.

When we add only hexose di-phosphoric acid to fluoride containing maceration juice, the ester is slowly converted into phosphoglyceric acid and glycero-phosphoric acid, at the same rate at which it is fermented in the absence of fluoride. If glucose alone, instead of hexose di-phosphoric acid, be added to maceration juice containing fluoride, no esterification takes place; for as I had observed earlier, glucose alone in the presence of fluoride is not esterified. It is different, however, when glucose and hexose di-phosphate are added simultaneously. In this case, glucose is esterified, but only to a certain extent. The reaction stops when a quantity equimolecular to the hexose di-phosphate has been esterified. The reaction is rapid, proceeding again with the same velocity as sugar fermentation in the absence of fluoride. Also this reaction produces a mixture of esters, consisting of almost equal quantities of glycero-phosphoric acid and phosphoglyceric acid. This is shown in equation A in Table 2.

TABLE 2. New fermentation equations (with sodium fluoride).

A. 1 Hexose di-phosphoric acid = 2 α-Glycero-phosphoric acid
+ 1 Glucose + 2 Phosphoglyceric acid
+ 2 Phosphoric acid

B. 2 Acetaldehyde 2 Alcohol
+ 1 Glucose = + 2 Phosphoglyceric acid
+ 2 Phosphoric acid
↑
(Hexose di-phosphoric acid)

Addition of acetaldehyde changes this system altogether. The reaction proceeds further, aldehyde becomes alcohol and sugar is simultaneously esterified, but all the glucose that enters into the reaction is now converted into phosphoglyceric acid. Glycero-phosphoric acid appears only to the extent that hexose di-phosphate is decomposed. The esterification and oxidation of the glucose proceeds until all the aldehyde has been converted into alcohol. As in this case the extent of the reaction depends not upon the quantity of hexose di-phosphate, but upon the amount of acetaldehyde added, the concentration of the hexose di-phosphate can be reduced to a large degree and yet accomplish the conversion of the sugar until the reaction is stopped by exhaustion of the aldehyde supply. In this manner an extremely small quantity of hexose di-phosphate, less than a tenth of a milligram per cubic centimetre of fermentation mixture, can lead to the esterification of fifty or a hundred times as much glucose. If one uses only a trace of hexose di-phosphate, then equation B in Table 2 is exactly satisfied. Here the hexose di-phosphate does not enter into the equation. It acts like a true catalyst. Actually, in the presence of acetaldehyde, hexose di-phosphate added in excess does not enter into the reaction, taking no part whatsoever in the course of reaction B. The velocity of reaction B is exactly as great as the maximum fermentation velocity of sugar. The necessary quantity of hexose di-phosphate is not larger than that which I found necessary fifteen years ago to initiate the fermentation, that is, to abolish the induction period, in maceration juice.

To explain further these peculiar intermediate reactions, I should like to add two more points.

(1) In place of hexose di-phosphoric acid, glyceric aldehyde phosphoric acid can be used. It behaves in both equation A and equation B practically the same as hexose di-phosphate. If it be assumed that

only *one* optical antipode enters into reaction, then the quantities of organic phosphorus necessary to accomplish the same amount of esterification are approximately the same. Thereby, the velocity of the rearrangement of the glyceric aldehyde phosphoric acid is greater than that of hexose di-phosphoric acid, while on the other hand the system glucose plus hexose di-phosphate reacts somewhat more rapidly than the system glucose plus glyceric aldehyde phosphoric acid. The glyceric aldehyde phosphoric acid can also be used to abolish the induction period. There is thus nothing to contradict the supposition that glyceric aldehyde phosphoric acid is formed as an intermediate product.

(2) The rôle of the acetaldehyde in the progress of the esterification consists in the oxidation of the momentary reaction products. One can therefore replace the acetaldehyde fairly well with other reducible systems, for example, methylene blue. Thus, the esterification can be conducted in accordance with equation B, using methylene blue instead of acetaldehyde. In this case, the oxidation product seems to be also phosphoglyceric acid. Therefore, methylene blue can also be used similarly to acetaldehyde as an activator of fermentation. The aldehyde reacts obviously with a nascent triose phosphoric acid produced from the reaction between glucose and hexose di-phosphate. At the same time the aldehyde prevents the rearrangement of the triose phosphoric acid into glycero-phosphoric acid, so that the entire triose phosphoric acid is oxidised to phosphoglyceric acid. Everything gathered together results in the fermentation scheme shown in Table 3.

Here, in accordance with data obtained from kinetic studies it is necessary to separate the initial period of fermentation from the stationary state. In this case also, fluoride alone inhibits reaction B, while iodoacetic acid does not inhibit B, but does inhibit reactions A and C.

This new scheme will be seen to agree with all known facts. It explains the esterification of the phosphates, the characteristic catalytic rôle of the hexose di-phosphoric acid and the part played by acetaldehyde in determining the initial period. It shows fermentation further as an oxidation-reduction process in which most probably the dismutation of two aldehydes, acetaldehyde and glyceric aldehyde phosphoric acid, play the crucial parts. Finally, it brings the carboxylase into the process in an easily conceivable manner. The difference between alcoholic fermentation and lactic acid formation is to be found in the fate of the pyruvic acid. While pyruvic acid in muscle extract is reduced to lactic acid by the glycero-phosphoric acid, in yeast, it is split up into carbon dioxide and acetaldehyde, which acetaldehyde is then reduced. This reduction, however, is not accomplished by the glycero-phosphoric acid, but by some precursor, probably the glyceric aldehyde phosphoric acid. This circumstance determines the peculiar disproportionality of the reaction chain and compels us to set up one equation for the initial period and another for the stationary condition. The periods of induction and rising fermentation are, as well known, not present in lactic acid formation.

The recognition of these facts, which are all more or less connected with the Embden scheme of lactic acid formation, has brought us a good step forward and I think that now a large number of previously known facts may be fitted into a unified picture.

TABLE 3. New fermentation scheme.

INITIAL PHASE			
A.	1 Hexose di-phosphoric acid + 1 Glucose + 2 Phosphoric acid	= 4 Triose phosphoric acid	= 2 α-Glycero-phosphoric acid + 2 Phosphoglyceric acid
B.	2 Phosphoglyceric acid	= 2 Pyruvic acid + 2 Phosphoric acid	= 2 Acetaldehyde + 2 Carbon dioxide + 2 Phosphoric acid
STATIONARY CONDITION			
C.	2 Acetaldehyde + 1 Glucose + 2 Phosphoric acid	= 2 Triose phosphoric acid + 2 Acetaldehyde	= 2 Alcohol + 2 Phosphoglyceric acid

The British Association at Leicester

ON the eve of a meeting of the British Association, the members about to converge on the chosen site begin to take a lively interest in its merits and demerits.

A booklet of a hundred pages entitled "A Scientific Survey of Leicester and District", prepared for the Leicester meeting, partly answers this and shows very clearly the inescapable advantages and disadvantages of position revealed in the accounts of the geology and climate; the natural features that result in its flora and fauna; and the development by man of its economic possibilities described under farming and under industries of Leicester. This association of factors and interlocking of cause and effect is well brought out by the editor of the booklet, Dr. P. W. Bryan, in his account of Leicester in its regional setting.

The corporate work of the citizen is described by the Town Clerk in a brief résumé of the rapid increase of activities since the establishment in 1835 of the new municipal body, particularly in relation to trading undertakings. Education, as a very special part of municipal responsibilities, is presented by the director of education, Mr. F. P. Armitage.

These accounts give prominence to the extreme administrative activity and forward thinking which resulted in the reorganising and in particular the re-grouping by 1929 of all the council schools in Leicester, in such a way as to make possible

educational provision more closely related to individual need and capacity. What may be termed the welfare aspect has been developed *pari passu* by means of playing fields and by constant remedial help.

The section on men of science in Leicester and Leicestershire cannot fail to be of special interest to members of the British Association and its well-wishers, for it is by workers rather than by facilities—though these have become increasingly necessary for modern work—that science advances.

The late but timely appearance of the new "Flora of Leicestershire and Rutland" by A. R. Horwood and the late Lord Gainsborough (London: Oxford University Press, 35*s*. net) no doubt accounts for the omission from the section of some, more particularly concerned with this type of work, who would otherwise have found a place.

The flora now hot from the Press is indeed no mere flora but a massive compilation of information about the plants of the district, written to a large extent in the modern ecological and genetical spirit by Mr. Horwood, who was connected with Leicester and its museum for so many years. The introduction alone takes up some three hundred pages and includes not only accounts of the characteristic plant groupings of certain districts but also features of the topography, geology and agriculture.

In the "Scientific Survey" account of men of science connected with Leicester, many worthy names occur, but the most outstanding are those of Alfred Russel Wallace and Henry Walter Bates of Amazon fame. Born in the first quarter of the nineteenth century, within two years of one another, they early became fast friends. Bates, apprenticed to a hosier, found education and delight in Charnwood Forest, while Alfred Russel Wallace enlivened the tedium of the life of a schoolmaster by the enthusiastic cultivation of the study of botany with the establishment of a herbarium. Fired by Charles Darwin's "Journal of a Naturalist" they went to the Amazon together in 1848, and some years after there appeared Bates's "A Naturalist on the Amazon" and later, Wallace's Linnean contribution paralleling and indeed preceding Charles Darwin's theory of evolution. No greater thing has come out of Leicester.

Altogether the survey presents an interesting and stimulating account of the factors operating in and about Leicester and of the human response which makes it a continually improving city. Visitors will probably be interested in the *means* which have been taken to secure a good water supply, to dispose of its sewage in spite of the awkward basin shape of the site and to foster the welfare and education of its young citizens. The readers of the booklet, however, may wish that they had been supplied with more information concerning the development of university education and research in this region and all that has come with it during the last decade in the way of exposition and research in the sciences. The University College, in spite of many handicaps, has equipped and sent out students, some of whom were of the highest merit, able to take honourable positions in industry or the services, and it has fostered the spirit of research and been the *fons et origo* of many publications on pure science and its applications. During this period a record number of eminent scientific workers of rare lecturing capacity have been induced by the College to give freely of their best to Leicester. It is a sign of the trend of modern times and not unfitting in the city of Wallace and of Bates that a large proportion of these eminent investigators have been biologists.

Obituary

Dr. V. H. Veley, F.R.S.

DR. V. H. VELEY, who died on August 20, aged seventy-seven years, was my tutor from 1896 until 1900, and during term time I used to see him at least two evenings a week in his house in Norham Road, as well as working with him in the laboratory near the Parks about three mornings a week. At that time he had attained his fellowship of the Royal Society, and a considerable reputation, through his paper on the "Hydrate Theory of Solution", which was at the time the subject of controversy, and had been made the subject of partisan feeling by the followers of the ionic dissociation theory of solution which was advocated by Ostwald. We, as Dr. Veley's pupils, had naturally to read both sides of the question, and just as naturally, I think most of us had leanings towards the views of our tutor. In the laboratory, whereas it cannot be said that he was a driver for idle pupils who wished to do as little work as possible, there was no doubt if one did take an interest he was always ready to help one in difficulties, and he had a very clear style in explaining and teaching.

At one period during the time when I was up, there was a large quantity of Demerara rum shipped to Great Britain, which, when let down from 40° overproof to standard strength, developed what was known commercially as 'cloudiness and floaters'. In some cases this faultiness became almost like a sediment of frog spawn in the rum puncheons. Dr. Veley, jointly with his wife, investigated this, and they discovered a micro-organism which was named by him *Coleothrix Methystes* (from the Greek for 'drunkard', a rather happy suggestion of Mr. Arthur Sidgwick). It is a remarkable organism insomuch as it is capable of living in alcohol 40° overproof in an attenuated condition, and when dilution takes place it is able to increase at such an extraordinary pace that it

produces 'faultiness'. Our tutor's investigations on this subject were of far greater interest to us, as pupils, than working for the 'schools'.

Outside his work, Dr. Veley was always a very delightful man to meet socially, and took an interest in all that went on in the College. At an earlier date he had coxed the University crew in May, 1877 (Head of the River), and to one who was so much interested in rowing as well as chemistry, it was a happy combination.

JOHN A. TINNE.

DR. VELEY'S vigorous and piquant personality impressed all who had the privilege of his friendship. He had a vivid memory, a deep fund of humour and dry wit. The acuteness of his mind and his power of swift observation—gifts which made him eminent in scientific inquiry—showed themselves in all his conversation. There was a kindly tartness in his talk, making his conversation memorably individual.

He felt strong affection for Rugby, and his memories of his old school found expression in speeches at meetings of former members of the school house. He was one of the most distinguished among his surviving contemporaries.

At Oxford Dr. Veley did work of great value both as an investigator and as a teacher. His intellectual force contributed to the growing influence of his department. A member of University College he was one of the body of men who, through their work in the laboratories and by the instruction of their pupils, strengthened year by year the position of science in Oxford.

His French ancestry meant much to him. There was a French quality in his mind. He remembered how much of him had its roots in Auvergne and in French Switzerland. His family were living at Yverdun in the earlier years of the nineteenth century and he recalled what he had heard members of an older generation say about Pestalozzi.

M. E. SADLER.

WE regret to announce the following deaths:

Prof. W. G. Craib, regius professor of botany in the University of Aberdeen, an authority on the flora of Siam, on September 2, aged fifty-one years.

Mr. A. H. Kidd, secretary of the University Grants Committee for the past eleven years, on August 27, aged forty-eight years.

Sir Philip Magnus, Bt., for many years superintendent and secretary of the Department of Technology of the City and Guilds of London Institute, on August 29, aged ninety years.

Major Robert Mitchell, C.B.E., vice-president of the Polytechnic, Regent Street, W.1, Director of Education at the Polytechnic in 1873–1922, on August 27, aged seventy-eight years.

News and Views

Physico-Chemical Mechanisms and Vital Properties

IN his presidential address to the British Association delivered at Leicester on September 6 and printed in the Supplement to this issue of NATURE, Sir Frederick Gowland Hopkins reviews, with a competence all his own, some of the recent triumphs of biochemistry. He shows with a wealth of apt illustration how important biochemical research has become, not only for the well-being of the human race, but also for the progress of biological thought. He rightly claims that "in passing from its earlier concern with dead biological products to its present concern with active processes within living organisms, biochemistry has become a true branch of progressive biology. It has opened up modes of thought about the physical basis of life which could scarcely be employed at all a generation ago. Such data and such modes of thought as it is now providing are pervasive, and must appear as aspects in all biological thought". No one, we imagine, will seriously dispute this claim. Great interest is attached to the President's references to the further question, so important for biology, "Can the living organism be adequately treated as a physico-chemical system?" To this question a cautious answer is given. He claims only that on the chemical level the activities of the organism can be fully interpreted in physico-chemical terms alone, and he adds that there are other and higher levels of organisation where it is by no means certain that physico-chemical concepts will suffice.

THE same question was discussed by Dr. James Gray in his presidential address to Section D (Zoology) on "The Mechanical View of Life". Dr. Gray regards it from the point of view of the experimental zoologist, which is not the same as that of the biochemist. While the latter is interested primarily in studying the living *parts* of the organism (though not ignoring their relations to the whole), the aim of the experimental zoologist is, or should be, to understand the activity of the organism as a whole. Obviously he also may properly use the methods of the biochemist and the physiologist, but he runs up against difficulties at once. How is it possible, for example, to give any adequate account from this point of view of the processes of regulatory development? Living systems are immensely complex, and show "intrinsic potentialities" which are quite without parallel in the inorganic realm. The zoologist, therefore, while accepting what help he can from the chemist in the study of the physical and chemical properties of living matter, should not shirk this greater problem of the study of the distinctively vital properties of living systems; in this field "biology must be the mistress, not the servant of physics and chemistry—she must make her own foundations, and build on them fearlessly". Dr. Gray rejects the dogmatic application of mechanistic method in a refreshingly outspoken way. Further comment on these important and illuminating addresses is made in our leading article (p. 365).

U.S. National Recovery Act Oil Code

THE American petroleum industry has adopted a code of fair competition, which aims at adequate and economic supplies of petroleum and its products by eradicating such abuses in all branches of the industry as may cause fluctuations in supply inconsistent with actual demand. It further seeks to conserve and prevent wastage of natural resources; to rationalise internal organisation by standardising wages and improving labour conditions; and to give practical effect to the policy implied by the National Industrial Recovery Act. Production is to be balanced so far as possible against demand, as estimated by federal authority, allocated equitably among the several States by the said authority, and finally subdivided by State authorities into pool, lease and/or well quotas. Similarly, to prevent unbalanced accumulation of gasoline inventories in any part of the country, and to facilitate equitable access of refiners to the permissible supply of crude oil, the country is to be divided into refining districts by a federal agency authorised to declare proper ratios between inventories and sales of gasoline in the respective districts.

MARKETING conditions imposed by the oil code summarily enforce the posting of prices by retailers and wholesalers of all grades of petroleum; they will prevent deviation from such posted prices by rebates, allowances, etc. and establish a fixed schedule of credit pertaining to the whole industry. In addition, a detailed schedule of equipment prices to be used as a basis of purchase or sale between oil companies is appended. The terms of the code are to be enforced and the administrative duties carried out by a committee representing the industry and by a federal agency to be designated by the President. The federal agency will be responsible for estimates of petroleum demand and for recommendations re quotas, allocations and inventories as stated above. The industry as a whole is under obligation to supply such necessary technical data and statistical reports as may be required for the effective administration of the code.

IT is as yet early days to appreciate the full force of this unique recovery act in the United States and its influence on the economic and social life of the community as a whole, and already in other industries there are signs that its immediate results have not been up to the optimistic anticipations of its sponsors. As applied to the oil industry, it is clearly undergoing a most acid test, since no industry in the United States has suffered so much from lack of co-ordinating influences. Quite apart from the economics involved, obedience to the code must inevitably bring with it drastic changes in the technical control of the industry, particularly as it affects drilling, production, conservation of reserves and refinery practice. If it succeeds, its repercussions will be world-wide, for America having put her house of petroleum in order, it will be impossible for other countries not to come into line. The code as it stands is the nearest approach to State control of a key industry which has ever been framed in the United States.

The Rubber Research Association

THE present plight of the Research Association of British Rubber Manufacturers is a deplorable example of the results caused by an absence of any stabilised policy of financing industrial research. This Association was established in 1920, and has hitherto been maintained by voluntary subscriptions from individual manufacturing concerns, and by grants from the Department of Scientific and Industrial Research, out of the £1,000,000 fund set aside by Parliament in 1917 for industrial research in general. The Association has performed work of the utmost value to the community and to the industry as a whole. That work has had the effect of making the smaller units in the industry much more efficient, and it is to be feared that the resulting increase of efficiency in the smaller units has created a feeling of apprehension in some of the larger units, accompanied by an unwillingness—and even point blank refusal—to contribute further. Thus the value of the Association's work has contributed to its undoing. An endeavour was made by friends in the House of Commons to place its finances on a stable basis by promoting the Rubber Industry Bill, which provided for a small compulsory levy on all imports of raw rubber. After a troubled history the Bill was adopted by the Government last May: but later the Government dropped it, apparently in consequence of the opposition raised by some elements of the industry.

IT would be a national calamity if the valuable work of the Rubber Research Association were allowed to be stopped for want of adequate financial support. The Government has now made an offer to the Association to contribute on what may roughly be described as a pound per pound basis, that is, to contribute as much money as the Association can raise by voluntary contributions from the industry. At best, this can only leave the Association with a fluctuating income; and a fluctuating income is precisely the type of revenue that makes systematic planning ahead impossible. Anything short of stabilised revenue inevitably results in wasteful expenditure (as in the case of the Forestry Commission). It is applying rule of thumb methods to scientific work; and thus things move in a vicious circle, bringing about a negation of true economy. However, the last word has not been said on this subject. The Association is receiving powerful backing from influential quarters. It is understood that the Association of Chambers of Commerce, the British Science Guild, and the Association of Scientific Workers are taking joint and individual steps, with the view of securing more adequate financial support to enable the Research Association to tide over its period of difficulties, and to make possible the retention of its experienced technical and scientific staff.

Thomas Allan, F.R.S., 1777–1833

ON September 12, 1833, Thomas Allan, the Scottish mineralogist, died at the age of fifty-six years. Born in Edinburgh, he was educated at the High School and then entered his father's bank. On a visit to Paris, after the peace of Amiens of 1802, he made the acquaintance of some French men of science and began collecting minerals. In 1808, he published an alphabetical list of minerals in English, French and German, and afterwards contributed papers to the Royal Society and the Royal Society of Edinburgh. His name is intimately associated with that of the romantic Sir Charles Giesecke (1761–1833) otherwise Karl Ludwig Metzler—"a wanderer from Germany, learned in mineralogy, explorer, actor, journalist, Freemason, the friend of Mozart and of Schiller, and perhaps the original of William Meister". Giesecke, who had studied under Werner, had had a school of mineralogy at Copenhagen until the bombardment, and had then gone mineral collecting in Greenland. In 1811 he shipped a large collection of minerals to Denmark, but the ship being captured first by a French privateer and then by a British frigate, was brought to Leith and the minerals were purchased by Allan for £40. Two years later, Giesecke arrived in Hull with another collection and then learnt the fate of the first. Proceeding to Edinburgh, he was hospitably received and soon after was given the appointment of professor of mineralogy in the Royal Dublin Society. He died, in Dublin, a few months before Allan. In the study and improvement of his own collection Allan, for some years, was assisted by the Austrian geologist Wilhelm Haidinger (1795–1871) and it became the best in Scotland. After Allan's death it was sold and ultimately came into the possession of Robert Philip Greg (1826–1906), from whom it was purchased in 1860 for the Natural History Department of the British Museum.

Research Exhibit at the Shipping Exhibition

AT the Shipping, Engineering and Machinery Exhibition, which was opened at Olympia, London, on September 7, a comprehensive exhibit has been arranged by the Department of Scientific and Industrial Research to illustrate the work done by the Department itself and associated research bodies, to assist the British shipping and engineering industries. The William Froude Laboratory and the Engineering and Metrology Departments of the National Physical Laboratory, and the Chemical Research Laboratory have exhibits illustrating some of the investigations carried out at Teddington, while the Fuel Research Station, Greenwich, has one exhibit dealing with fires in bunkers and colliers, and another with pulverised fuel. The exhibit of the Chemical Research Laboratory illustrates the important investigations, carried out in many parts of the world, on sea-water corrosion. Progress in the iron, steel and non-ferrous metals industries is largely due to the British Non-Ferrous Metals Research Association, the British Cast Iron Research Association and the Industrial Research Council of the National Federation of Iron and Steel Manufacturers, all of which have exhibits illustrating their many activities. Their exhibits range from the new lead alloys for electric cable sheathings and heat-resisting cast irons, to the coke for coke ovens and blast furnaces, and steel ingots. It is safe to say that there is no engineering shop or shipbuilding yard in Great Britain which does not benefit from the researches illustrated at Olympia. The Exhibition will remain open until September 23.

The Expanding Universe

WE have been used to hearing strange things about the expanding universe. Prof. de Sitter contributes to the June issue of the Royal Astronomical Society's *Monthly Notices* an article which is largely of a non-mathematical character and will throw light on the subject for those of our readers who have been unable to follow the elaborate discussions of the last few years on the subject: he advances the quasi-paradoxical view that the *stars are older than the universe*. It is, he says, possible to adopt a point of view in which the "beginning of the universe" is no more remarkable a phenomenon than the passage of a comet through its perihelion. It is then possible to maintain a longer time scale for the individual stars—as is demanded by theories of stellar evolution based on Eddington's mass luminosity relation—than is accordant with the interval which has elapsed since the galaxies started expanding, as judged by the observed recession of the spiral nebulæ. It must be borne in mind that the expansion of the universe is the separation of galaxies, and leaves each galaxy unaltered, and that the galaxies can easily interpenetrate. The beginning of the universe, or minimum of one of the quantities connected with the universe, took place about ten thousand million years ago, but the stars are much older. At this minimum the galaxies interpenetrated: and during this interpenetration the chance of stellar encounters was, of course, greater than it is now that our galaxy is left to itself. Modern theories of the origin of the earth suppose that our planetary system is the result of a close approach to the sun of some star. Now the evidence of the earth's crust points to an age of the earth of this order of magnitude, and it appears conceivable that the earth was formed at the "beginning of the universe" but that the sun was not, the "beginning" of the universe being simply a time of minimum separation (indeed, interpenetration) of the galaxies, the stars in which had already been in existence for some time.

Progress in Facilities of Transport

A PUBLIC lecture, entitled "Transport for a Century", was delivered by Sir Henry Fowler on September 5, in connexion with the Leicester meeting of the British Association. Probably no single item has played so great a part in the advance of civilisation during the past hundred years as the progress in ease of transportation. The rapidity of actual transport of persons and material has effected a very great change indeed in the life of people and

countries. It has been said that all transportation is material waste and if this is so, this source of waste has been very much reduced during the past century, although this may not always be realised as fully as it should. This reduction has been largely due to the improvement of roads, both for horse and power driven vehicles, resulting in greater efficiency, and applies both to roads of earth, stone, etc., and to those using iron and steel rails. It has been also due to the employment of mechanical means of propulsion not only on these roads but also through the air itself.

SIR HENRY FOWLER did not deal with propulsion through water, important as it is. He began with a reference to the Leicester and Swannington Railway, which formed so important a step in the commercial development of railways a century ago. This line was essentially due to the courage and forethought of the men of Leicester and its neighbourhood. Up to 1897, mechanical transport on roads was hindered by Government restrictions, with the result that Great Britain was ten years behind the Continent in starting development on these lines. Great Britain was also somewhat behind in transport in the air. In both cases, however, through the knowledge the country had in alloy steels, etc., and in engineering efficiency, it was possible to recover lost ground rapidly. The general scientific knowledge available assisted very materially in the advances in aeronautics. As a result Great Britain has been in the forefront in all types of speed of transportation in recent years. Sir Henry Fowler referred to the recent 15-ton motor unit for use in the development of fresh country both in the Dominions and Colonies. This has been produced under the supervision of the Overseas Mechanical Transport Directing Committee which was appointed by the Government. The lecture was concluded with a short film showing the performance and possibilities of this vehicle.

Recent Archæological Discoveries in Great Britain

SEVERAL announcements of archæological discoveries of considerable interest have been made within the last few days. Of these, the prehistoric settlement in Papa Westray, Orkney Islands, excites hope of a second Skara Brae. Two large stone buildings, said to be of a type new to Scottish archæology, have been exposed at Hower. The tops of the walls were covered by 6–8 ft. of sand, which had to be cleared away before the buildings were seen. One of the buildings was found to be in an excellent state of preservation, the walls standing to the height of 6 ft. The second, however, had suffered considerable damage. The two structures are connected by a passage and open on to a street, which, unfortunately, has disappeared before the encroachment of the sea. It has been possible to plan the structures; but no evidence of the period of occupation has as yet been obtained. The excavations are being carried out by Mr. William Traill of Papa Westray and Mr. W. Kirkness of Edinburgh. A second discovery comes from the Isle of Man, where a gardener at Douglas unearthed a bronze age urn beneath a flat slate slab. There was no indication of the existence of a cist or mound. The urn is 17 in. high and 12 in. wide at the mouth, and undecorated, except for irregularly placed dots on the lip. An unusual feature is that the urn stood on its rounded bottom, under which was a white pebble propping it up. Further search revealed the broken remains of another urn about 5 ft. to the south. Underneath this was a platform of black earth with carbon, in some places showing much burning. It is possible, therefore, that this second find represents the vestiges of the incineration, of which the food vessel previously found formed a part. The find is described in the *Times* of September 5.

IN the same issue of the *Times* will be found a report on recent excavations in Salmonsbury Camp at Bourton-on-the-Stour, Gloucestershire. Previous discoveries of Iron, Roman and Saxon Age have pointed to this district as being of considerable archæological interest. Salmonsbury Camp itself is an Iron Age structure of some fifty-six acres in extent, which is now being excavated by a local committee under the supervision of Mr. G. C. Dunning of the London Museum. An early Iron Age hut-site was first discovered near the centre of the camp and several similar hut-sites have since been found in other parts. These belong to the first century B.C. Twelve inches above the central Iron Age hut was the floor, partially cobbled and paved with flat stones, of a Roman hut, which yielded pottery and a third century coin. Intervening between these two periods of occupation came evidence of Belgic invasion, in the form of a Belgic hut within the ramparts on the north-west side of the camp. This hut proved rich in finds of pottery, two iron brooches, iron knives, pins, objects of bone, a stone spindle whorl, and worked flints. Fragments of iron and bronze slag and clay point to metal and pottery industries. It is thought that the numerous finds belonging to the Belgic period on the site, point to an invasion of those people, and to them, too, is attributed one of the less pleasing characteristics of the occupants of the site, namely the practice of cannibalism, indicated by the presence of the scattered bones of a female skeleton, some of which appear to have been split to obtain the marrow.

Electric Discharge Lamps

AT the tenth annual conference at Margate of the Association of Public Lighting Engineers, a paper was read on September 5 by Mr. G. H. Wilson on electric discharge lamps and their applications to public lighting. These lamps, which mark a considerable advance in the efficiency of light production, emit light not because any solid is made 'white hot' (as in the case of the filament of the ordinary electric lamp) but because a gas or vapour is 'excited' electrically. When a suitable gas at low pressure is sealed into a glass tube having an electrode at either end, it conducts electricity and light is emitted, the colour of which depends upon the gas used. Mercury vapour produces a blue light, helium an ivory white,

(*Continued on p. 405.*)